

Bolt Beranek and Newman Inc.

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Report No. 3460

**VELANET Communication Protocols between
the CCP and SIP and between the CCP and DP**

5 April 1977

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Report No. 3460 ✓

Bolt Beranek and Newman Inc.

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VELANET COMMUNICATION PROTOCOLS BETWEEN
THE CCP AND SIP AND BETWEEN THE CCP AND
DP

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This research was supported by the
Advanced Research Projects Agency of the
Department of Defense and was monitored by
AFTAC/VSC, Patrick AFB FL 32925,
under Contract No. F08606-75-C-0022 ✓

407 403
Computer Sys Dir

AFTAC Project Authorization No. VELA VE/4706/B/ETR
Program Code No. 4F10
Effective Date: 15 September 1974
Total Amount of Contract: \$580,969.00
Expiration Date: 14 February 1977

The views and conclusions contained in this document are
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Air Force Technical Applications Center, or the U.S. Government.

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TABLE OF CONTENTS

	page
1. INTRODUCTION.....	1
2. OVERVIEW.....	2
3. DATA BLOCK FORMATS.....	6
4. HOST LEVEL BLOCK AND MESSAGE HEADER AND CHECKSUMS.....	14
4.1 Block Header.....	14
4.2 Message Header and Checksums.....	14
5. ARPANET HEADERS AND PROTOCOL.....	16
5.1 Host-to-IMP Header.....	16
6. HOST PROTOCOL RULES.....	18
6.1 Normal Operation.....	18
6.2 Abnormal Operations and Restart.....	21
6.2.1 Communications and Control Processor (CCP).....	21
6.2.2 Detection Processor (DP).....	25
6.2.3 Seismic Input Processor (SIP).....	27
APPENDIX A.....	A-1
APPENDIX B: Data Status Field Formats.....	B-1

Name Section	
Bull Section	
LOCATION	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	AVAIL. and/or SPECIAL
A	

LIST OF FIGURES

	page
FIGURE 1: Message Structure.....	4

LIST OF TABLES

	page
TABLE 1: Block Type Identifiers.....	6

VELANET Communication Protocols Between the
CCP and SIP and Between The CCP and DP

1. INTRODUCTION

The VELANET, a seismic data collection network including approximately six on-line array stations, is being implemented by the VELA Seismological Center under DARPA sponsorship. The objective of the network is to provide data for research in nuclear test detection and identification. The Seismic Data Analysis Center (SDAC) will perform event detection and analysis to generate a network event list. The data collected by the network will be filed in a large digital storage facility at Computer Corporation of America (CCA).

The Communication and Control Processor (CCP) is the central node in the VELANET. It receives data from the seismic stations over leased line and ARPANET circuits, reformats the data as needed, and forwards selected data to the Seismic Input Processor (SIP) at CCA and to the Detection Processor (DP) over the ARPANET.

This document describes the revised protocols and formats for communication between the CCP and SIP, and between the CCP and DP. The revised protocols are expected to be implemented in the spring of 1977.

2. OVERVIEW

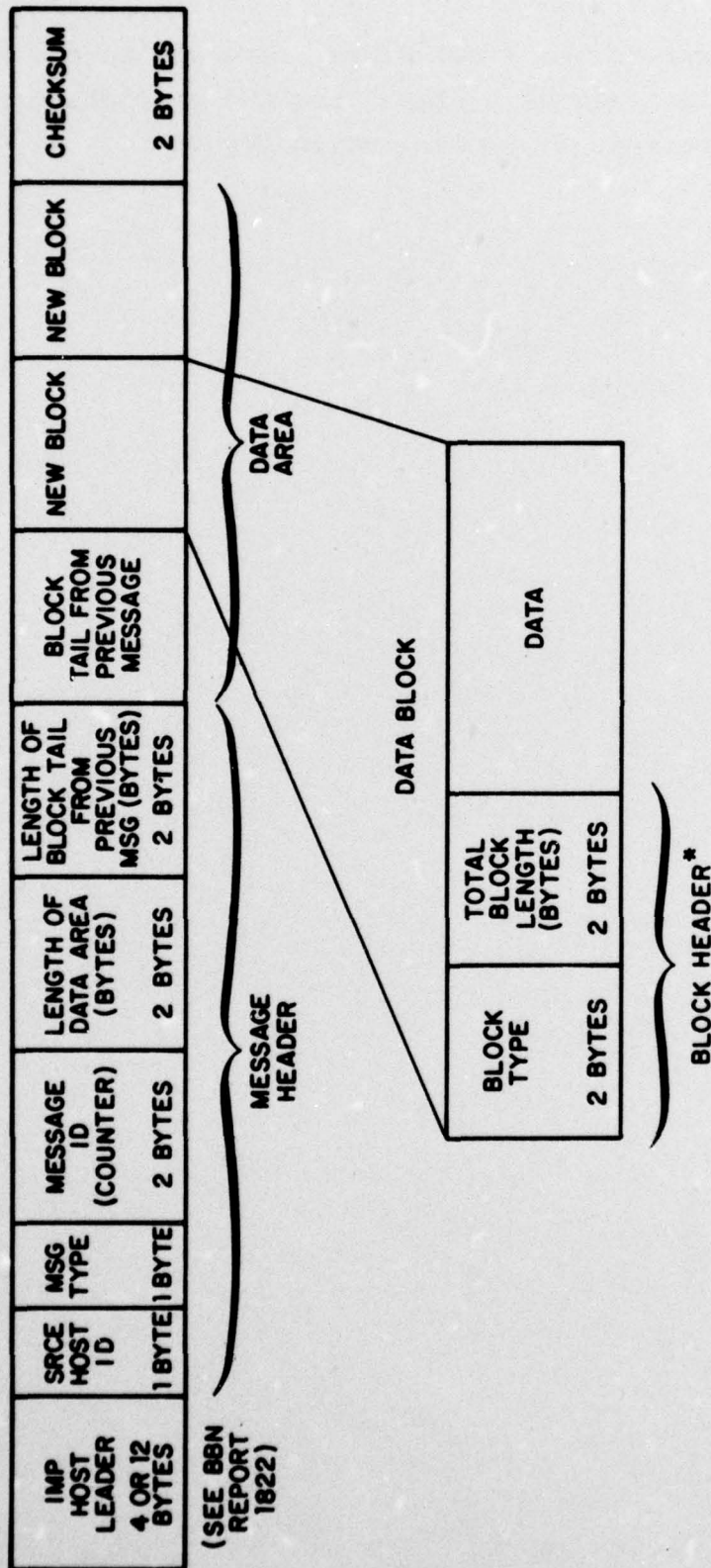
The amount of data that can be forwarded from the CCP is expected to be limited by the ARPANET capacity. It is, therefore, important to use the ARPANET efficiently. Load on the ARPANET resources is controlled by three parameters: 1) total bandwidth, 2) number of messages, and 3) number of "packets". Packets contain 1008 bits of data and messages contain up to 8 packets.

Optimum use of the network is achieved with full packets and full messages. In order to approach that goal, the protocols described in this document treat all communications except message acknowledgement as a continuous time sequence data stream. Whenever 7,968 bits of data are available in the stream, they are formatted into a message with 80 bits of message header and checksum information, and the message is transmitted. In order to avoid excessive delays, an alternate condition for transmitting a message is that data waiting to be sent is one second old. All messages will contain integer multiples of 2 bytes (16 bits) of data.

When the protocol rules for a particular path require message acknowledgement, the acknowledge messages will form a separate data stream. This avoids the excess traffic resulting from acknowledging acknowledge messages. On low data paths, the added acknowledge messages could be a majority of the traffic without this separate data stream.

Within each regular message, data is organized by fixed format blocks with different block formats for each of 6 types of data. Each block will start with a standard header giving the block type and length. A message in the main data stream does not have to start or end on a block boundary. The message header

includes an offset to the first block start within the message
(the length of the tail of a block from the previous message).
This message structure is summarized in figure 1.



* ACKNOWLEDGE BLOCKS WILL HAVE NO HEADER. EACH ACKNOWLEDGE MESSAGE IS A SINGLE ACKNOWLEDGE BLOCK.

FIGURE 1: Message Structure

Section 3 of this document will describe the detailed formats of the data in each data block type. Section 4 describes the block and message header and checksum formats. Section 5 describes the ARPANET message headers and some pertinent error control and flow control procedures and messages. The host level protocol rules are stated in Section 6.

3. DATA BLOCK FORMATS

There are seven types of data blocks used in communication among the CCP, the SIP, and the DP. Six of these will appear as blocks in the main data stream. Acknowledge data appears as separate messages. The six regular data block types and the corresponding type identifiers are listed in Table 1. The format of the data in each block type is described below.

TABLE 1: Block Type Identifiers

<u>Identifier</u>	<u>Data Block Type</u>
Ø	Seismic Data
4	Host Going Down
5	Operator Message
8	Status
9	SIP to Datacomputer Transfer Complete
10	Processed Data

Data Type 0: Seismic Data

Seismic Data blocks are transmitted from the CCP to the SIP and from the CCP to the DP. Each block contains data from one station. Data blocks will be time ordered. Data format of the Seismic Data is as follows:

Field 1: Bytes 1 to 8: Time-of-day

16 BCD characters as follows:

char.	use
1	0
2&3	two digits of the year
4,5,&6	three digits of day number
7,8	two digits of hours
9,10	two digits of minutes
11,12	two digits of seconds
13,14	two zeros for hundredths of seconds
15,16	padding-zeros

Field 2: Bytes 9 to 11: Site identity

3 ASCII characters of site name

Field 3: Byte 12: Site status

MSB=1: no data for this frame

MSB-1=1: communication block error this frame

Field 4: Seismic data including

Subfield 1: SP Status padded to a word boundary.

Data in this field is copied from the incoming data and, therefore, is site dependent. See Appendix B for formats.

Subfield 2: SP data: 10 or 20 samples (depending on sample rate) for each SP channel. Each sample is a 16 bit fixed point number. Samples are ordered in frames of 1/10 or 1/20 second each containing one sample from each seismometer.

Subfield 3: LP status padded to a word boundary. See Appendix B for format.

Subfield 4: LP data: 1 sample from each LP seismometer. Each sample is a 16 bit gain ranged number.

Data Type 4: Host Going Down

There are no data fields in a "Host Going Down" block.

Data Type 5: Operator Messages

The data consists of ASCII text bytes representing the operator message. The data field is padded to an even number of bytes (full 16 bit word boundary).

Data Type 8: Status Data

The status blocks are collected into a file in the archival storage. This file is used as 1) a record of the state of the seismic network nodes, and 2) a record of data available from the network. The CCP maintains a record of the status of all sites and nodes and reports changes to the SIP and to the DP. The SIP and DP will maintain a record of the CCP status and will make entries in the file when the CCP status changes.

The data format for status blocks is as follows:

Field 1: Bytes 1 to 6: Time-of-day coded as first six bytes of time in the Seismic Data block.

Field 2: Bytes 6 and 7: Number of status change entries in this block.

Field 3: Status change entries

Each entry consists of 14 bytes coded as follows:

3 bytes ASCII characters for site or node id.

LAØ = LASA

NAØ = NORSAR

CCP = CCP

SIP = SIP

DPS = DP

ØØØ = special case, complete network status will be reported in next block.

1 byte ASCII character for channel type

I = individual sensor

S = subarray beam

B = array beam

A = adaptive beam

E = special case, status applies to all channels at this site. This byte always E for SIP, CCP, and DPS. This byte is E for sensor stations when the smoothed missing message rate or checksum error rate exceeds threshold.

2 bytes ASCII characters for sample rate in samples per second. Zeros if channel type is E or site id is 000.

4 bytes ASCII characters for channel id within site. Zeros if channel type is E or site id is 000.

1 byte ASCII character for gain

H = high gain

L = low gain

Ø = channel type is E or site id is 000

1 byte ASCII character for sensor component

Z = vertical

N = north

E = east

T = transverse

R = radial

Ø = channel type is E or site id is 000

1 byte status bits coded as follows (bit 1 is MSB)

bit 1=1: no data or node down

bit 2=1: calibration or test

bit 3=1: communication error

bit 4=1: data suspect or bad

bit 5=1: CCP operator commanded no data or bad data

bit 6=1: CCP operator commanded calibration

bit 7=1: CCP operator commanded communication error

bit 8=1: CCP operator commanded data suspect

1 byte offset location of sensor in site data starting at 0. Zero if channel type is E or site id is 000.

Data Type 9: SIP to Datacomputer Transfer Complete

Whenever data is transferred from the SIP disk file to the Datacomputer, a type 9 block is sent to the CCP. Format of the data in a type 9 block is as follows:

Field 1: Bytes 1 to 4: Three bytes of site id and one byte padding.

Field 2: Bytes 5 to 14: Ten ASCII characters file name.

Field 3: Bytes 15 to 20: Starting time of the filed data using the same coding as the time-of-day field in the status block.

Field 4: Bytes 21 to 26: Ending time of the filed data using the same coding as the time-of-day field in the status block.

Data Type 10: Processed Data

Processed Data blocks are exchanged between the CCP and DP. They contain NORSAR detection and event data sent to SDAC, and LASA detection data to be sent to NORSAR. Format for the data in the processed data blocks from DP to CCP is as follows:

Field 1: Bytes 1 to 6: Time-of-day coded same as time-of-day in the Status block.

Field 2: Bytes 7 to 22 One SDAC Signal Arrival Queue entry to be entered into field 1 of the next CCP to NORSAR message.

16 byte entry coded as follows:

bytes 1 to 4: Signal start time in deciseconds
bytes 5 to 8: Signal stop time in deciseconds
bytes 9 and 10: Detecting beam number
bytes 11 and 12: Maximum short-time average
(MSTA) level
bytes 13 and 14: Long-time average (LTA)
bytes 15 and 16: Detection number (a counter
that is incremented by one in successive
messages and is reset when the SDAC DPS
system is initialized.)

The format for the processed data in the processed data
blocks from the CCP to the DP is as follows:

Field 1: Bytes 1 to 6: Time-of-day coded same as time-
of-day in the Status block.

Field 2: Bytes 7 to 24: NORSAR DP results from field
3 of the last message from NORSAR. Coding is
as follows:

4 bytes - Start time (decisecond)
4 bytes - Stop time (decisecond)
2 bytes(16 bits) - Beam number
 (Bits 0-3) - Number of subarrays down
 (Bits 4-15) - Beam number
2 bytes - MSTA
2 bytes - LTA
2 bytes - Detection number
 The detection number increments by 1 and is
 reset whenever NORSAR DP is initialized.
2 bytes - Partition code
 Bits 0-4 of last byte (filter code) is X'F'
 for general surveillance or X'O' for selected
 surveillance. Note that this assumes NORSAR
 will continue 2-partition DP processing.

When no detection is present, this field is encoded
as binary zeros.

Field 3: Bytes 25 to 80: NORSAR EP results.

56 bytes from the NORSAR EP file as received in field 8 of the last message from NORSAR. This field consists of a 4-byte integer transmission count which is incremented and stored with each transmission of this field; a 4-byte integer EPX number; and a 48-byte area containing data from the NORSAR automatic EP results file. If no EP results are present this field is coded as binary zeros.

Acknowledge Data Format

All messages between the CCP and SIP and between the CCP and the DP, except acknowledge messages, are acknowledged if they have correct checksums. Acknowledge data blocks are in separate message streams with one acknowledge block in each message. Acknowledge messages will not exceed one ARPANET packet (1008 bits).

Acknowledge messages have only one data field containing a list of the two byte message identifier counts from the headers of messages being acknowledged.

4. HOST LEVEL BLOCK AND MESSAGE HEADER AND CHECKSUMS

4.1 Block Header

Each of the data blocks described in section 3 above except the acknowledge block will have a four byte header appended when it is entered into its appropriate data stream. The standard block header format is as follows:

Field 1: Bytes 1 and 2: Block type. A 16 bit binary integer for the identifier given in Table 1.

Field 2: Bytes 3 and 4: Block Length: a 16 bit binary integer for the number of bytes in this block (including block header).

4.2 Message Header and Checksums

Each of the two data streams (one for all block types except acknowledge and one for acknowledge blocks) will be broken into messages of 996 bytes or less for transmission over the ARPANET. Each message will have an 8 byte host level header appended at the beginning and a 2 byte checksum added at the end.

The format of the header will be as follows:

Field 1: Byte 1: Source host identification

Field 2: Byte 2: Message type

1 = normal data stream message

2 = acknowledge data stream message

Field 3: Bytes 3 and 4: Unique message identifier in the form of a counter for messages to each receiving host. The counter provides both unique identification and sequence verification. The counter recycles from its maximum logical value of FFFF (hexadecimal) to the value 1. The counter will be reset to \emptyset whenever the sending host is restarted or has had to throw data away due to exceeding its buffer queue. The message identifier in acknowledge messages is never used, and its value is optional (sender's choice).

Field 4: Bytes 5 and 6: Length of the data part of the message (excluding message header and checksum but including block headers) in bytes.

Field 5: Bytes 7 and 8: Length of the tail of block from previous message in bytes (acts as an offset to beginning of the first block that starts in this message). Hexadecimal FFFF in this field indicates that no block starts in this message (e.g., the entire message is the end of a block that started in an earlier message). \emptyset indicates that the data area starts with a new block. This field is always \emptyset in acknowledge messages.

The checksum field will be a 16 bit value computed by subtracting the arithmetic sum of the 16 bit value of the words in the host level header and the data area of the message (exclude ARPANET header and the checksum field) from the number of 16 bit words included using binary two's complement 16 bit arithmetic.

5. ARPANET HEADERS AND PROTOCOL

5.1 Host-to-IMP Header

A Host-to-IMP leader must be appended to the head of each message to be transmitted via the ARPANET. There are now two versions of the Host-to-IMP leader format. The new version allows addressing more than 4 hosts on an IMP and more than 64 hosts in the network. The change is backward compatible, so only hosts on a fifth host port or an IMP numbered greater than 64, or a host communicating with another host in that category, are required to use the new leader. The CCP and DP will use the new leader. Both forms of leader are described below.

a) Old leader format

The old Host-to-IMP leader consists of 4 bytes coded as follows:

- bit 1: Priority bit=0 for VELANET messages.
- bits 2 to 8: zeros.
- bits 9 and 10: destination host number.
- bits 11 to 16: destination IMP number.
- bits 17 to 28: message id: code is sending host option.
- bits 24-32: zeros.

b) New leader format

The new Host-to-IMP leader consists of 12 bytes (96 bits) coded as follows:

- bits 1-4: zeros.
- bits 5-8: all ones.
- bits 9-37: zeros.
- bits 38-40: ones

bits 41-48: destination host.
bits 49-64: destination IMP.
bits 65-76: message id: code is sending host option.
bits 77-96: zeros.

6. HOST PROTOCOL RULES

6.1 Normal Operation

During normal operation the data exchange among the CCP, DP, and SIP include:

- a) One frame of seismic data, including short period and long period data from each operating site, is available at the CCP for transmission to DP and SIP. The subset of the data that is sent to each receiver is determined by parameters in the CCP. The CCP operator may be able to change these parameters by operator command, but the VELANET protocols do not include provision for dynamic changes. Initial data will be transmitted from the CCP in chronologic order. Retransmissions of lost or bad messages may occur at any time.
- b) Each second the CCP may have processed data to send to DP if NORSAR is operating. Each second the DP may have processed data to send to the CCP, but more likely every 2 minutes.
- c) Operator messages may be generated at the SIP or the CCP at any time.
- d) The CCP will monitor status of all other nodes and sites on the VELANET and will monitor status of all sensors. Whenever a change in status of sensors being sent to DP or SIP occurs, status change data will be sent from the CCP to DP and/or SIP. Whenever a change in SIP or DP status occurs, CCP will send a status change report to SIP and DP. Thus all status data will appear in both SIP and DP archival files except for complete network status entries on restart of SIP or DP.

SIP and DP will monitor CCP status and will generate a status block for CCP when the CCP status changes.

At midnight GMT, CCP will send the full status of the entire VELANET to SIP and DP.

- e) Whenever the SIP completes a transfer of data from the SIP disc file to the Datacomputer, the SIP will generate a data filed report for the CCP.

All of the above reports will be entered as data blocks in the main data stream buffers. Whenever there is enough data for any connection to generate a full ARPANET message or the oldest waiting data block is one second old, the data will be assembled into an ARPANET message and transmitted unless the connection would be blocked (see abnormal operation below).

Whenever a message from the main data stream is received with the correct checksum, an acknowledge report for that message is generated. Acknowledge data form a separate data stream. Acknowledge messages are transmitted at least once each second if any acknowledge data are present. Acknowledge messages are not acknowledged.

After transmission of a main data stream message, the sending node saves a copy of the message until it is acknowledged or allotted buffer space is filled. Messages will be retransmitted every five seconds until they are acknowledged or until the buffer must be reused. Five seconds is an initial value that may be changed on operational experience.

Since the CCP and possibly the DP may be on either of two host connections to the network, the correct host address will be determined as follows:

- a) The DP and SIP will send messages to the host address from which they received the most recent valid data message.
- b) The CCP will send messages to the host address entered by the CCP operator.

6.2 Abnormal Operations and Restart

The CCP, SIP, and DP must recognize and respond to several abnormal conditions. The symptoms and response to these conditions are summarized below. The more complex response sequences are described in more detail in Appendix A.

6.2.1 Communications and Control Processor (CCP)

a) DP or SIP communications about-to-block.

Symptom:

1. The CCP will keep a separate account of the oldest ARPANET messages in flight to DP and SIP. When 5 more recent messages have been transmitted, that communication stream is about to block. (Before the Pluribus IMP is installed at CCA, the SIP data stream will be about to block if 2 more recent messages have been sent.)

Response:

1. The CCP will not transmit any additional messages to the host that is about to block until a RFNM or lost message is received for the oldest outstanding message in that data stream.
2. The CCP will print an operator message
(time) SIP (DP) about-to-block
when the condition occurs and a message
(time) SIP (DP) unblocked
when transmission is resumed.

b) DP or SIP down or inaccessible.

Symptom:

1. Type 7 IMP-to-Host message received.

Response:

1. The CCP will attempt to transmit the rejected message every 1 to 2 seconds to test for return to normal operation. No other messages will be sent to the inaccessible host until the communication path is reestablished.
 2. CCP will print an operator message
(time) SIP (DP) down (type)
(type = numerical value of the subtype of the IMP-to-Host message)
when the condition is detected, and a message
(time) SIP (DP) up
when the condition ends.
- c) Data loss on the DP or SIP communication stream.

Symptom:

Buffer space available for the data stream is exceeded. This condition occurs if data can not be transmitted as fast as it is received, usually because the destination host (DP or SIP) is blocked or down.

Response:

1. Clear all data being buffered for that particular (DP or SIP) data stream and stop making new data blocks for that stream.
2. Restart the offending data stream (DP or SIP).*

*See Appendix A

3. Print an operator message tagged with the time of the oldest data lost
(time) SIP (DP) data lost
and, when communication is restored,
(time) SIP (DP) data restored
 4. Send status change messages to the other archiving host
(DP or SIP) giving time "no data" condition starts and ends.
- d) Host-to-IMP error or SDAC IMP down.

Symptoms:

1. IMP ready line down.
2. Type 1 or Type 8 IMP-to-Host message.

Response:

1. Reset IMP data stream.*
 2. Print a CCP operator message
(time) Host-IMP Error
and, when successful communications are resumed, print
an operator message
(time) Host-IMP good.
- e) DP or SIP saw CCP down.

Symptom:

1. Received a CCP down status change block from DP or SIP.

Response:

1. Print operator messages
(time) CCP down

*See Appendix A

(time) CCP up

2. Send status change blocks to the other (SIP or DP) archiving host showing CCP "no data" start and end times.

f) Incoming data stream reset.

Symptom:

1. Received message with id=Ø from SIP or DP.

Response:

1. Clear any partial data blocks from the source that sent the id=Ø message (DP or SIP).

2. Type operator message

(time) SIP (DP) reset

g) CCP Restart.

Symptom:

1. Operator or reliability code restart of CCP.

Response:

1. Clear buffers.

2. Reset IMP data stream.*

3. Reset output data streams to SIP and DP.*

4. Print operator message

(time) CCP Restart

5. If first message from DP or SIP contains a CCP down status change, send CCP down (and up) status change messages to archival stores (SIP and DP).

*See Appendix A

6.2.2 Detection Processor (DP)

The DP must recognize and respond to at least the following abnormal conditions:

a) Incoming data stream from CCP reset.

Symptom:

1. Received a message from CCP with id=0.

Response:

1. Delete any partial incoming data blocks being saved pending completion.

2. Reset incoming message id reference.

b) Host-to-IMP error or SDAC IMP down.

Symptom:

1. IMP ready line down.

2. Type 1 or type 8 IMP-to-Host message.

Response:

1. Reset the IMP data stream.*

c) CCP down or inaccessible.

Symptom:

1. IMP-to-Host type 7 message.

*See Appendix A

Response:

1. Test for CCP up by attempting to send a CCP down status change message periodically until it is successful.
2. Enter CCP down ("no data") status change in archival storage.
3. Send a CCP up status change and resume normal operation.
4. Enter CCP up ("no data" bit off) status change in archival storage.

d) DP restart.

Symptom:

1. Operator restart DP system.

Response:

1. Reset IMP data stream.*
 2. Reset CCP data stream.*
- e) DP out of buffers for CCP messages.

Symptom:

1. Buffer space for messages to CCP full. (Probable causes are blocking of Host-to-IMP data or CCP down.)

*See Appendix A

Response:

Since all messages from DP to CCP are the result of operations internal to DP, not forwarding continuous data from input data streams, the DP has two choices:

- 1) DP can stop making up output messages for CCP until buffers are available,

or

- 1) DP can clear all data being buffered for CCP except CCP down status and stop making up new output messages.
- 2) Restart CCP data stream* when buffers available.

6.2.3 Seismic Input Processor (SIP)

The SIP must recognize and respond to the same conditions as the DP with corresponding responses.

*See Appendix A

APPENDIX A

The procedures for resetting the Host-to-IMP data stream and the Host-to-Host data stream are described below.

Reset the IMP data stream: in order to reset the IMP data stream, the host will:

1. Set the host ready line up and monitor the IMP ready line until it is up.
2. Transmit 3 Host-to-IMP type 4 NOP messages to the IMP.
3. Retransmit the Host-to-Host message that caused the IMP-to-Host error message, if any.
4. Resume normal operation.

Reset the Host data stream: in order to reset the data stream to an individual host (CCP, SIP or DP), the sending host will:

1. Reset the message id counter for that data stream to 0.
2. Prepare and attempt to send a message to the receiving host with id=0 and the following data blocks:
 - a) If the CCP is the sending host, and the time of data that was lost is known from the time of the oldest buffer that was cleared or from an incoming CCP down status change message, the first data block will be a status change block showing "no data" for the receiving host (SIP or DP) at that time.

- b) If the CCP is the sending host, a status change block for the entire VELANET for the time of restart will be included. This status change will show the receiving host (SIP or DP) up ("no data" bit off).
 - c) The first normal block to be sent after the reset.
- 3. Wait for the acknowledge for the above message with $id=\emptyset$.
 - 4. Resume normal operation.

APPENDIX B: Data Status Field Formats

Only LASA and NORSAR stations include status fields in the data messages. The format of these fields is described below:

1. LASA

a) Short Period Data Status

<u>Subfield Length (Bits)</u>	<u>Subfield Use</u>
156	Per each of 13 beams, there are 12 bits. Bit 0: 1 = not present Bit 1: 1 = calibration Bits 2-11: 1 = bad more than X% of time
4	Zeros
18	Per each of 6 raw sensors, there are three bits. Bit 0: 1 = not present Bit 1: 1 = calibration Bit 2: 1 = bad/operator encoded
14	Zeros
60	One bit for each of 6 raw channels repeated every 1/10 sec. Bit value: 1 = bad (parity/glitch detected)
<u>4</u>	Zeros
256	Total SP Status Field Length

b) Long Period Data Status

<u>Subfield Length (Bits)</u>	<u>Subfield Use</u>
120	There are four bits per each of the 30 LP channels. Bit 0: 1 = absent Bit 1: 1 = calibration Bit 2: 1 = data bad Bit 3: 1 = operator declared channel bad
<u>8</u>	Zeros
128	Total LP Status Field Length

2. NORSAR

a) Short Period Data Status

<u>Subfield Length (Bits)</u>	<u>Subfield Use</u>
48	There are 16 bits per each of 3 SP channels Bits 0-3: type of channel ID 4-15: channel or beam number of data
<u>1</u>	SP repeat indicator
<u>15</u>	Zeros
64	Total SP Status Field Length

b) Long Period Data Status

<u>Subfield Length (Bits)</u>	<u>Subfield Use</u>
66	One bit for each LP sensor: i.e., 3 bits/subarray with order LV, LN, LE. If status bit = 1, error.
12	Zeros
<u>1</u>	Undefined
<u>1</u>	LP repeat indicator
80	Total LP Status Field Length

NOTE: NORSAR Long Period Status Field will be changed to the following format, probably in April of 1977.

<u>Subfield Length (Bits)</u>	<u>Subfield Use</u>
21	One bit for each high gain LP sensor, 3 bits/subarray in order LV, LN, LE.
3	One bit for each low gain LP sensor.
13	Zeros
3	Low gain subarray identity
7	Zeros
<u>1</u>	LP repeat indicator
48	Total LP Status Field Length

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 3460	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) VELANET COMMUNICATION PROTOCOLS BETWEEN THE CCP AND SIP AND BETWEEN THE CCP AND DP		5. TYPE OF REPORT & PERIOD COVERED Interim Technical Report
7. AUTHOR(s) Howard W. Briscoe		6. PERFORMING ORG. REPORT NUMBER BBN-3460
9. PERFORMING ORGANIZATION NAME AND ADDRESS Bolt Beranek and Newman, Inc. 50 Moulton Street Cambridge MA 02138		8. CONTRACT OR GRANT NUMBER(s) F08606-75-C-0022, ARPA Order-2551
11. CONTROLLING OFFICE NAME AND ADDRESS Advanced Research Projects Agency/NMRO 1400 Wilson Boulevard Arlington VA 22209		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS ARPA Order 2551 Program Code 4F10 Project VT/4706/B/ETR
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) VELA Seismological Center 312 Montgomery Street Alexandria VA 22314		12. REPORT DATE April 5, 1977
		13. NUMBER OF PAGES 35
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED 11 5 Apr 77 12 38 p.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Seismic Data Network Host Protocol Communication Protocol		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The North American Network for collecting and storing seismic data uses the ARPANET for communication between the Communications and Control Processor (CCP), the Detection Processor (DP), and the Seismic Input Processor (SIP). This document describes the Host protocols and message formats used for communication among these processors. 407 403		